PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Method of and Apparatus for Coating Webs

We, COMMERCIAL PLASTICS LIMITED, a British Company, of Willington, Wallsend, Northumberland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to the production of coated webs of sheet material and provides a method of and apparatus for coating such webs.

Webs of sheet material such as paper or film are commonly coated with materials such as synthetic resins to modify their properties, for example their permeability to air, moisture or other media. To confer a desired property on a web by coating, it is usually necessary to apply to the web not less than a definite minimum thickness of coating material and if the coating is uneven a greater average thickness of coating material is required to ensure that no portion of the web has less than this minimum thickness. Many materials with which it is desired to coat webs of paper or film are by no means cheap, and substantial economies can be effected if methods of applying more even coatings can be found.

The present invention provides a method of and apparatus for applying coating of exceptional evenness to webs to sheet material

In the method according to the invention a liquid coating composition is caused to flow down an inclined plane to a sharp edge at the lower end thereof, the liquid during its flow down the plane being dammed back and released in controlled manner whereby the evenness of flow to the sharp edge is enhanced, a web is passed over a counterelectrode spaced from the sharp edge and the composition is atomised at the sharp edge and deposited on the web by means of a high potential difference maintained between the edge and the counterelectrode.

Th apparatus according to the invention includes an inclined plane of which the free lower edge is formed as a sharp edge for electrostatic atomisation, means for feeding a liquid coating composition to the upper end of the plane, a horizontal equalising member extending across the surface of the inclined plane to dam the flow of the composition and by releasing it in a controlled manner to enhance evenness of the flow below the member, a counterelectrode spaced from the sharp edge and over which the web can be passed and means for maintaining a steady high potential difference between the sharp edge and the counterelectrode to effect atomisation of the composition at the sharp edge and its deposition on the web.

The equalising member may constitute either a weir having a horizontal edge over which, or a retainer blade having a horizontal edge beneath which, the composition must pass to flow down the plane. Both weir and retainer blade can be used on the same inclined plane and are applicable to both the distribution conduit and feedroller methods of supplying the composition.

An even flow of composition down the inclined plane requires an even supply of composition to the upper end of the plane. One method of achieving this is to feed the composition through a conduit which distributes the composition evenly along the upper end of the plane. An example of such means is a perforated distribution tube, which is preferably arranged over a distribution trough having a horizontal edge over which the composition flows onto the plane.

An alternative method of supplying com-

position to the plane is to use a rotating feed roller in contact with the upper edge of an inclined doctor blade which constitutes the plane. In this case the feedroller can conveniently be supplied with composition by allowing the lower part of the roller to dip in a bath of the composition and rotating the roller at a steady and preferably adjustable speed.

The most suitable potential for the electrostatic field varies with the coating composition employed, but can be determined by simple comparative trials. The plane may be charged positively or negatively and the counterelectrode earthed or vice versa. Alternatively, the plane and counterelectrode may be charged to high potentials of opposite sign.

The angle of inclination of the plane is important, although the best angle can be determined by simple experiment in any given case. In general, too steep an inclination causes "stringing" of the composition while too gentle an inclination gives an inferior feed of composition leading to poor results. The most sutable angle has been found to be of the order of 45°, and this does not appear to vary significantly with the potential employed or with the nature of the coating composition.

The method may be employed for any liquid coating material, for example solutions or lacquers of plastics. Pastes can also be applied in this way, but if solid pigments are present they should be very finely ground. When suitable heating is provided, melts may be sprayed by the method.

The behaviour of the coating composition in the field may be improved in the case of a lacquer by adjusting the balance of solvents which it contains and, in the case of compositions generally, by the incorporation of additives which modify relevant physical properties of the composition, for example conductive additives. The use of additives of these types can permit satisfactory spraying of coating materials not otherwise readily applicable by electrostatic atomisation. Examples of such additives are polar or otherwise amphipathic organic compounds such as salts, amides and polyglycol esters of organic acids having a long hydrocarbon chain in their molecules. Quantities of one or more such additives, preferably up to a total of 6% by weight of the total composition, may be employed.

For the production of the most even coatings, the provision of one or a pair of auxiliary electrodes is preferred, and any such electrodes should be parallel to the sharp edge and spaced on one side or the other of the path of tragel of atomised composition from the sharp edge to the counterelectrode. An upper auxiliary electrode at a potential of the same sign as that of the counterelectrode is the more desirable as it assists in countering the effect of gravity, which tends to drag the dispersion below the level of the counterelectrode. A lower auxiliary electrode may be at a potential of opposite sign to that of the counterelectrode; it may on the other hand be at a potential of the same sign, but then should not be too close to the counterelectrode. For best results, metal spheres should be provided at the two extremes of the sharp edge to control the disposition of the field.

Where a feed roller is used, it must be capable of feeding composition evenly to the doctor blade, and is preferably an accurately turned roller with a smooth surface. The inclined plane must likewise be accurately made and is preferably either stiffened to preserve the accuracy of its contour and edge or, where extreme accuracy is not required, resilient. Resilience of the plane corrects minor irregularities or eccentricities, and resilience of at least the upper edge of the plane is eminently desirable where the plane is constituted by a doctor blade in contact with a rotating feed roller. As mentioned above, it is generally best for the plane to be inclined at an angle of the order of 4[illegible] but this need apply only to the greater part of the depth of the plane, and the sharpened portions near the upper and lower edges can differ somewhat in inclination without affecting the spraying properties of the plane.

It is convenient for the plane to be wholly of metal, and where a feed roller is used and is of metal it will in operation be at the same potential as the sharp edge. Where coating composition is applied to a feed roller by rotating the roller in a bath of the composition, the box or trough containing the composition may be of an insulating material such as synthetic resin, but if of metal it will normally be at the same potential as the sharp edge. Where a distribution tube and trough are employed, these may be at the same potential as the plane, and, like a feed roller and box, should be supported on appropriate insulators.

Embodiments of the method and of the apparatus of the invention will be described by way of example. In the description of the apparatus, reference will be had to the accompanying drawings in which:

Fig. 1 is a diagrammatic vertical section of one form of electrostatic coating apparatus to which the invention can be applied, and

Fig. 2 is a similar view of a modified form of apparatus embodying the invention.

The apparatus shown in Fig. 1 employs a feed roller and includes a metal trough 10 mounted on insulators 11 and an accurately worked steel roller 12 with a polished surface, mounted horizontally in bearings so that its underpart is within the trough. The roller is driven by means of a long rubber

driving belt 13 from a remotely located electric motor, the speed of which can be adjusted.

A heavy steel doctor blade 14 is stiffened on its underside and is mounted at an inclination of 45° to the horizontal with a resilient accurately sharpened upper edge 15 in contact with the descending side of the feed roller. The upper surface of the blade is carefully polished and is for the most part inclined at 45°. The uppermost portion however is at a slightly smaller inclination where it tapers to the sharpened upper edge of the blade. The lowermost portion may, if desired, be at a slightly greater inclination where it tapers to the sharp lower edge 16, at which atomisation occurs. The lateral extremities of the lower edge carry brass spheres 17 which serve to control the field at the edges of the blade.

Parallel to the lower sharp edge of the blade, and spaced from it in a direction of about 45° downwards, is a metal roller 18 serving as counterelectrode. The roller is mounted in bearings supported by insulators (not shown). A planar strip auxiliary electrode 20 may, if desired, be electrically connected to the counterelectrode roller and mounted parallel to and above it, and in a plane parallel to the blade, as indicated at 20, the auxiliary electrode thus being itself inclined at an angle of 45° to the horizontal. A similar second auxiliary electrode may also be electrically connected to the counterelectrode roller and mounted below and parallel to the edge of the roller nearest the blade and in a horizontal plane, as indicated at 21.

Let-off and take-up mechanism (not shown) is provided to pass a continuous web 22 such as paper or film around the counterelectrode, guide rollers being used to guide the web from a point below and beyond the counterelectrode roller, round the counterelectrode in an upward direction and, passing and behind the upper auziliary electrode, to a warm air drier (also not shown). The speed of the web advancing mechanism may be adjustable.

The rate at which the composition is supplied by the roller can be varied by adjusting the speed of rotation of the roller, and the thickness of the coating applied to a web can thus be controlled by adjustment of the speed of movement of the web or the speed of rotation of the feed roller, or by a combination of these adjustments. With coating compositions of high viscosity, or which tend to gel, it may be beneficial to warm the composition. The resulting reduction in viscosity may require the feed roller to be speeded up to maintain the desired output.

Electrical connections are made up to the blade 14 on the one hand and to the counterelectrode 18 (and auxiliary electrodes 20 and 21 when employed) on the other hand and a high tension D.C. generator is provided (not shown), either one terminal of which is earthed, or each terminal of which is connected to a respective part of the apparatus.

According to the invention, this apparatus includes an equalising member, for example as described below in connection with Fig. 2.

In working with this apparatus it has been found that good results are obtained when a negative potential of from 40 to 75 kV is applied to the blade and the counterelectrode earthed. Satisfactory results can however be obtained when a positive potential is applied to the blade or when equal positive and negative potentials are applied to the blade and counterelectrode respectively or vice versa, and the best numerical value of potential varies with the coating composition employed. It has also been found that the preferable size for the counterelectrode roller is a diameter of 5 to 6 inches. With a roller of this size, a suitable distance between the sharp edge and the counterelectrode is some 5 to 6 inches.

With reference now to Fig. 2, the modified apparatus employs a distribution trough and includes an inclined blade 25 supported and stiffened by the brackets 26 and mounted on insulators 27. At its upper end the blade carries a distribution trough 28, having a horizontal edge 29 constituting a weir over which coating composition must pass to flow down the blade. A perforated distribution tube 30 carries composition from a source of the composition (not shown) and maintains the desired level of composition in the trough 28. The lower end of the blade terminates in a sharp edge 31 at which atomisation of the composition takes place.

An equalising member in the form of a retainer 32 with an accurately worked lower edge 33 is carried by brackets 34 provided with screw adjustments 35. The lower edge 33 of the retainer blade is narrowly spaced from the upper surface of the blade 25, the spacing determining the volume of liquid composition flowing to the sharp edge 31 in unit time. It is preferred that the lower edge 33 of the retainer blade should be at a point more than half way down the inclined blade 25, but may be at any convenient distance from the sharp edge.

As in the other embodiment described, terminal spheres 17 may be provided at either end of the sharp edge, and a counterelectrode roller 18 is arranged for the continuous passage of a web 22. One or more auxiliary electrodes may be provided, if desired, and electrical connections are made to the blade and the counterelectrode as before.

The following are examples of procedures in which various coating compositions are applied by either form of apparatus described in the preceding paragraphs and including

an equalising member as required by the present invention.

EXAMPLE I.

A solution of silicone release lacquer is prepared in a lead- and zinc-free stirring vessel at room temperature. 5 lbs. of Midland Silicone Resin MS 2219 is mixed with 14 parts by weight of methyl isobutyl ketone and one part of tetrahydrofurfuryl alcohol, and after stirring 0.15 part of Midland Silicone Catalyst N 27 is added. The trough of the apparatus is filled with the mixture and the revolving furnishing roller is so adjusted that over a 48" width 300 cc. of lacquer are carried per minute; the potential is set at −65 kV on the blade, the counterelectrode being at earth potential. The running speed of the paper is adjusted so that a final deposit of 0.3 g. sq. metre is deposited and the coating is cured in a circulating air oven at a temperature of 160°C. The cured coating provides an excellent release surface for pressure-sensitive adhesive tapes.

EXAMPLE II.

A PVC protective coating is applied to paper in order to impart oil and grease resistance. A solution of vinyl chloride copolymer VAGH is prepared as follows:—

	parts by weight
VAGH	3.64
Butyl acetate	14.2
Methyl isobutyl ketone	9.65
Tetrahydrofurfuryl alcohol	1.0
Butyl alcohol	1.28
Polypropylene laurate	1.21

After the mixture has been stirred until completely dissolved it is placed in the trough of the spraying head, and feed roller is adjusted to carry 400 cc. per minute over a 48" width and a dry coating weight of 20 g. per sq. metre is applied using a voltage of −70 kV at the blade, with the counterelectrode at earth potential. The coating is applied to a paper base, and dried in a circulating air oven at 120°C.

EXAMPLE III.

A polyvinyl chloride plastisol suspension is prepared by mixing the following ingredients in a Pony Mixer followed by a grinding operation on a triple roll mill.

The ingredients used are:

	parts by weight
Polyvinyl Chloride (Geon Type 121)	50
Di-iso-octyl phthalate	50
Tween 80 (registered trade mark)	5.0
Advastab CZ11 (registered trade mark	1.0
Stearic acid	5.0

This suspension is sprayed onto a lightweight fabric at a trough temperature of 45°C., a flow rate of 300 cc. per minute and a dry coating of 10 g. per sq. metre is deposited with a voltage of −60 kV applied to the blade and the counterelectrode earthed. The coating is fused into a homogeneous film by passage through an infra-red oven followed by contact with an embossing roller. The coated fabric may be used for weather-proof garment applications.

EXAMPLE IV.

A lacquer is prepared consisting of:

	parts by weight
⅛ sec. Nitrocellulose Linters	10.5
Cyclohexanone	5.0
Butyl acetate	5.0
Methyl ethyl ketone	15
Toluene	5.0
Ethyl alcohol	5.0
White spirit	5.0

The spraying head is so adjusted that a uniform coating of 7 g. per sq. metre dry weight is applied to paper, the potential applied to the spraying edge relative to the backing electrodes being −65 kV. The coating is then air dried using a high air flow fan. This produces a high-gloss decorative coating which may be used as an overprint varnish.

EXAMPLE V.

A lacquer is prepared consisting of:

	parts by weight
Polyvinylidene Chloride Resin (Viclan A90/ol)	4.45
Cyclohexanone	22.5
Tetrahydrofurfuryl alcohol	8.0
Methyl glycol acetate	5.0
Methyl ethyl ketone	4.5

The spraying head and speed of advance of a regenerated cellulose film are so adjusted that a uniform coating of 2 g. per sq. metre dry weight is applied to the film, the potential applied to the spraying edge relative to the backing electrodes being −65 kV. The coating is then dried using high air flow. The film has a greatly improved resistance to penetration by water vapour and can be heat sealed to itself.

WHAT WE CLAIM IS:—

1. A method of coating a web in which a liquid coating composition is caused to flow down an inclined plane to a sharp edge at the lower end thereof, the liquid during its flow down the plane being dammed back and released in controlled manner whereby the evenness of flow to the sharp edge is enhanced, a web is passed over a counter-electrode spaced from the sharp edge and the composition is atomised at the sharp edge and deposited on the web by means of a high

potential difference maintained between the edge and the counterelectrode.

2. A method according to Claim 1 in which the dammed liquid is allowed to flow over a horizontal edge, whereafter it continues to flow to the lower edge of the plane.

3. A method according to Claim 1 in which the dammed liquid is allowed to flow through a gap formed between the plane and a horizontal edge spaced therefrom, whereafter it continues to flow to the lower edge of the plane.

4. A method according to any of Claims 1 to 3 in which the composition is fed to the plane through a conduit which distributes the composition evenly along the upper end of the plane.

5. A method according to any of Claims 1 to 3 in which the liquid composition is fed to the upper edge of a doctor blade by a rotating feed roller in contact with the upper edge of the blade.

6. A method according to Claim 1 substantially as hereinbefore described with reference to any of the Examples.

7. Apparatus for coating a web, comprising an inclined plane of which the free lower edge is formed as a sharp edge for electrostatic atomisation, means for feeding a liquid coating composition to the upper end of the plane, a horizontal equalising member extending across the surface of the inclined plane to dam the flow of the composition and by releasing it in a controlled manner to enhance evenness of the flow below the member, a counterelectrode spaced from the sharp edge and over which the web can be passed and means for maintaining a steady high potential difference between the sharp edge and the counterelectrode to effect atomisation of the composition at the sharp edge and its deposition on the web.

8. Apparatus according to Claim 7 in which the equalising member constitutes a weir having a horizontal edge over which the composition must flow to reach the lower end of the plane.

9. Apparatus according to Claim 7 in which the equalising member is a retainer blade closely spaced from the surface of the inclined plane and having a horizontal edge beneath which the composition must flow to reach the lower end of the plane.

10. Apparatus according to Claim 8 or 9 having one equalising member which is disposed at a point more than half the distance of travel of the composition down the inclined plane.

11. Apparatus according to any of Claims 7 to 10 including a perforated distribution tube arranged to feed the composition to the upper end of the plane over the whole width of the plane.

12. Apparatus according to Claim 11 in which the distribution tube is disposed over a distribution trough having a horizontal edge over which the composition flows onto the upper end of the plane.

13. Apparatus according to any of Claims 7 to 10 in which the plane is constituted by an inclined doctor blade the upper edge of which is in contact with a rotatable feed roller, and the apparatus includes means for supplying the composition to the feed roller.

14. Apparatus according to Claim 13 in which the rotatable feed roller is partially immersed in a trough containing the liquid coating composition.

15. Apparatus for coating webs substantially as described with reference to and as shown in the accompanying drawing.

16. Coated webs produced by a method according to any of Claims 1 to 6.

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1017576 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

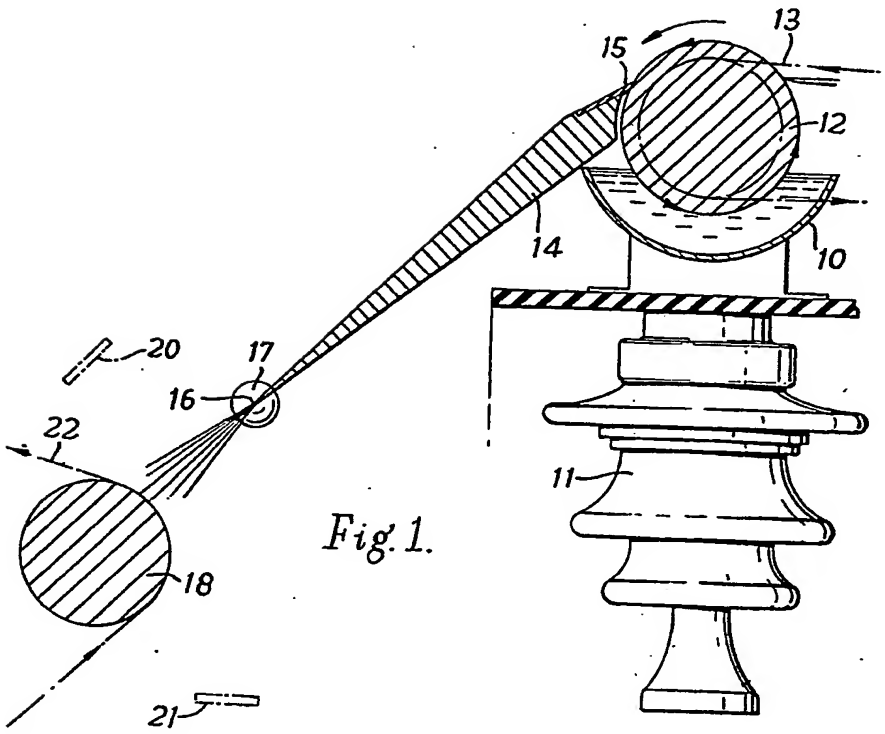

Fig. 1.

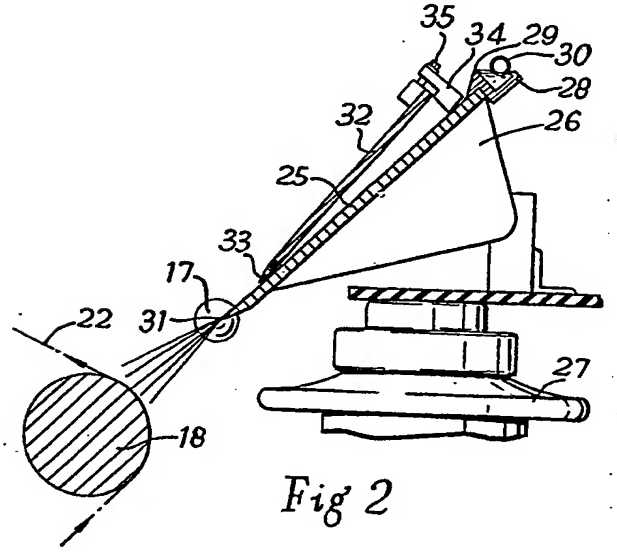

Fig 2